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Weight Optimization of Engine Mounting Bracket for Commercial Vehicle by Using FEA Packages

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Abstract - Right now, car part planning is totally grounded on strength and lightweight according to as portability is worried for execution improvement. Thus, for saving of cost in item styles of the hall of the machine and with thought of the heaviness of passage in which a district can be concentrated having lower stresses will be cut inside figure of the hallway. The fundamental motivation behind a machine mounting type is to help the power - train framework in a machine in all states of street shells including for sure, lopsided street shells. It's authentically sensitive to change the supporting areas and the kinds of help after the machine is raised, the mounting classes should be justified in the plan stage. This plan contains the investigation of streamlining of a machine mounting type and correlation among being and upgraded machine mounting type. Improve model will fabricate utilizing aluminum material with the supporting of glass fiber subcaste. Computer aided design model has been created through back designing. The sort of Mahindra Scorpio Motor is to be taken for study. Subsequent to examining the machine mounting sort of 4-wheeler, Improvement is finished. Trial testing will perform with assistance of UTM and strain check.

Key Words: CAD/CAM, Ansys, Engine Mounting Bracket.

1.INTRODUCTION

In this auto period the requirement for light weight underlying gear is adding as there's a further focus on energy utilization decrease and improvement in lessening the migration. The greatness of item volumes has customarily put extreme circumstances on the power of cycle utilized in assembling. The producers have solid importance on the expense has the interest for the component to improve the material exhibition and to convey this gear for minimal price is the interest. In machine area the very serious auto business needs producers to give a great deal of consideration to voyaging solace. resonant vibration is from shaky millions live inside the machine body, this is making the contrivers guide their focus toward the occasion of top quality machine mounting classes to affirm that there's upgrade in riding solace. The interest for cutting edge playacting machine mount classes ought not be killed by emerge inside the item costs or potentially improvement process duration. In diesel machine, the machine mounting type is the serious issue as there's unthrottled condition and high level compression rate and for sure there are further speed anomalies at low speed and low weight when contrasted with fuel machines. So because of this there are more vibration excitation. By this vibration machine mount type might come up short, so by streamlining the shape and thickness of machine mount type we can enhance the exhibition at unique plan stages. By certain investigations it's seen that classes saved 38 of mass. Primary improvement is a significant device for an ideal plan; correlation as far as weight and component execution underlying streamlining ways is a viable apparatus to create progressed quality items at lower cost.

ENGINE MOUNTING BRACKET:
Engine mounts themselves are little parts that are intended to settle, as well as appropriately adjust, a vehicle's motor. Thus, despite the fact that these mounts are little, they assume an enormous part in the general usefulness of the core of your vehicle. Also, when these apparently little and minor parts of the vehicle turn sour. A car motor body-case framework is regularly exposed to unequal motor powers, lopsided terminating powers particularly at the sitting rates, shaking powers and forces due to responding parts, dynamic excitations from gearboxes and embellishments, and street excitation. These propensities bring about undesired vibrations which lead to an awkward ride and furthermore

cause extra burdens in the car casing and body. Vibrations are irritating and their starting point can be hard to distinguish. A motor mounting framework incorporates a front mount, a back mount, a motor mount, and a transmission mount. Establishment levels and spring constants of each mount are foreordained to such an extent that most of the heaviness of the power train is upheld by the front and back mounts. Mounting tomahawks of the motor mount, front mount, and back mount are vertical while the mounting pivot of the transmission mount is horizontal. The transmission mount might incorporate scaffolds which shift its spring steady during vehicle roll. There are many valid justifications to versatilely mount a motor and additionally transmission one progressively significant explanation is to diminish structure bone commotion and vibration produced by the motor and sent to the vehicles administrator compartment. Tough mounting will likewise give longer life to casing and motor block mounting sections, suspended parts and transmission by weakening transient shock inputs and working force loads. The paper additionally sums up motor aggravations takes a gander at a few ideal down to earth mounting approaches and brings up significant restricting contemplations. At long last, determination models and required information for appropriate motor mounting are framed. A construction for mounting a motor for a vehicle containing: a front motor mount for mounting the motor on a front side of the motor in a longitudinal heading of the vehicle, the front motor mount including a motor mount section which is fixed toward one side thereof to a suspension part and has an encasing hung on the opposite end thereof, the front motor mount mounting the motor with the protector mediated between the motor and the motor mount section, the cover supporting a motor section fixed to the front side of the motor, wherein a space is given between the front side of the motor and the motor mount section; and a helper gear arranged in the space between the front side of the motor and the motor mount section, wherein the front motor mount has a strength against a heap applied thereto in the longitudinal bearing of the vehicle not exactly that of the assistant hardware. In this paper the front motor mount section as displayed in figure 1 is thought about.

Requirement of Engine Mounting Bracket

The mounts can cause a variety of problems for your vehicle.

1. Engine Vibration

The main side effect to note is an exorbitant measure of motor vibration. Since engine mounts are intended to keep a motor secure, terrible mounts will prompt an unreliable motor that will skip about. On occasion, there might be a sound radiating from the motor implying of vibration, be that as it may, the more normal side effect is a felt vibration on the traveler's side. In the event that you don't frequently have guests sitting on the traveler's side that can see you something is off-base, put your hand on the traveler's seat now and again to check for exorbitant vibration.

2. Misalignment

Getting an engine secures a motor, however adjusts it, implying that the motor's level is guaranteed to be equivalent on all sides. Assuming that the engine mounts are as a matter of fact terrible, the motor will list and hang aside. Once more, there might be clamors producing from the motor that don't sound very right. Review the motor to check whether it is shifted. Provided that this is true, your mounts aren't going about their business. In any case, assuming the motor is shifting unnecessarily, a motor block might result. As such, your vehicle might halt abruptly. Really look at the motor for hanging and, provided that this is true, supplant all engine mounts as the need should arise.

3. Engine Damage

The third side effect is an outrageous case. On the off chance that engine mounts sever totally from a motor, and are not simply free or broken, a motor can move starting with one side then onto the next, skipping about. This presents a security risk on the off chance that you are driving your vehicle in high velocities; the motor might move and skip about so savagely that different parts will take off.

4. Broken Belts and Hoses

Other than in a roundabout way breaking motor parts, terrible mounts can prompt harmed belts and hoses. Once more, these different motor fan belts and radiator hoses will be harmed exclusively during high velocities.

5. Excessive Noise

Prior side effects incorporate parts that are just not working, from motor parts to belts and hoses. Be that as it may, the most well-known side effect is simply overabundance commotion. Note any thumping or banging, as this general commotion implies something is off-base. It might mean one of the past side effects, or something totally new, however paying little mind to what the issue is, it implies that you realize something is off-base and to quickly take your vehicle in for fixes.

Fig.01 Engine Bracket Mounting

During plan of vehicle structures, it's continuously overwhelming to accomplish progressed firmness and strength and contemporaneously lessen weight, that is to say, to enhance the designs. There have been beautiful kinds of improvement styles that were created and have effectively been utilized in the vehicle structure plan. subsequently, these classes experience various plan changes all through the vehicle advancement process. What's more, the classes are for the most part made of solid metal with strong convoluted shapes and enormous consistence, yet have basic freight cases. This large number of conditions make the classes ideal campaigners for the improvement activity, for sure however on a basic level the streamlining styles can apply to any primary corridor.The machine mount framework incorporates a machine, three to four machine mounts and an establishment (vehicle body). Since the machine is the biggest moved mass in the vehicle and on the off chance that it isn't properly compelled and protected, it'll bring forth environment in the vehicle body and front facing end distance embodiment. Th geste of the machine mount frameworks not just relies upon the presentation of individual mounts, yet additionally on the total framework also. The plan of a machine mount framework includes the accompanying (1) the place of machine focus of graveness (C.G.) and its openness, (2) position and openness of individual mount, (3) determination of solidness parts of each mount.

1.2 Material selection:

For conventional materials, the chose materials are EN45 and SUP9, which are standard materials, and their properties are recorded in Table 1. Contrasted and ordinary materials, carbon strands and E glass Epoxy was picked as a cross breed material which has high strength.

Properties of Conventional Material

Properties	EN45	SUP9
Young's Modulus (Mpa)	) 2.E+5	2.1E+5
Tensile Strength (N/mm2)	1960	1962
Poisson Ratio	0.3	0.27
Density (kg/mm3)	7850	7850

Properties of carbon fibres

Parameter	Value
Tensile modulus	294 GPa
Tensile strength	5880 MPa
Density	1.8 g/cm3
Thermal conductivity	70 W/m.K
Major Poisson's ratio	0.28

Properties of E glass fibres

Parameter	Value
Tensile strength (GPa)	3.445
Young's modulus (GPa)	72.3
Elongation (%)	4.8
Poison's ratio	0.2
Density (g/cm3)	2.58

Carbon fiber is, precisely what it seems like - fiber made of carbon. In any case, these fibers are just a base. What's by and large related to as carbon fiber is a material adjusting of genuinely slender strands of carbon bits. At the point when bound along with plastic polymer gum by intensity, pressure or in a vacuum a compound material is shaped that is areas of strength for both featherlight. blade and other hard development accessories have upset the field of assiduity. Presently, a phase has come that there's a need of a superior material to find the developing necessities and requests of the ultramodern culture. This need has purchased up a fresher material to the field which is presently known as Carbon Strands. Carbon fiber is one of the rearmost supporting accessories utilized in blends. It's a genuine howdy tech material, which gives genuinely great primary bundles, better than those of any pith. Carbon fiber has an elasticity almost multiple times lesser than that of blade, yet is4.5 times lower thick. Carbon fibers are carbon filaments with upsides of Youthful's modulus somewhere in the range of 150 and 275 to 300 GPa Carbon fiber material has a great many tasks, as it very well may be framed at bright consistence in unimaginable shapes and sizes. Carbon fiber is regularly molded into tubing, texture, and material, and can be exceptionally shaped into quite a few compound passageway and pieces. Carbon fiber is an extraordinarily helpful material utilized in blends, and it'll keep on developing assembling demand share. As additional styles of creating carbon fiber blends monetarily are created, the cost will proceed to fall, and more iligence will exploit this interesting material. Carbon Fiber has a High Solidarity to Weight rate (otherwise called explicit strength) Strength of a material is the power per unit region at disappointment, separated by its consistency. Any material that is solid AND light has a positive Strength/weight rate. Accessories comparable as Aluminum, titanium, magnesium, Carbon and glass fiber, high strength sword mixes all have great solidarity to weight rates. The accompanying table 4 are presented for examination just and will change contingent upon structure, blend, sort of arachnid, thickness of wood and so on.

The units arekN.m/ kg.

Carbon Fibre	2457
Glass Fibre	1307
Spider Silk	1069
Carbon Epoxy Composite	785
Balsa axial load	521
Steel alloy	254
Aluminium alloy	222
polypropylene	89
Nylon	69

Carbon Fiber is very rigid

Carbon fiber reinforced plastic is over 4 times stiffer than Glass reinforced plastic, almost 20 times more than pine, 2.5 times greater than aluminium.

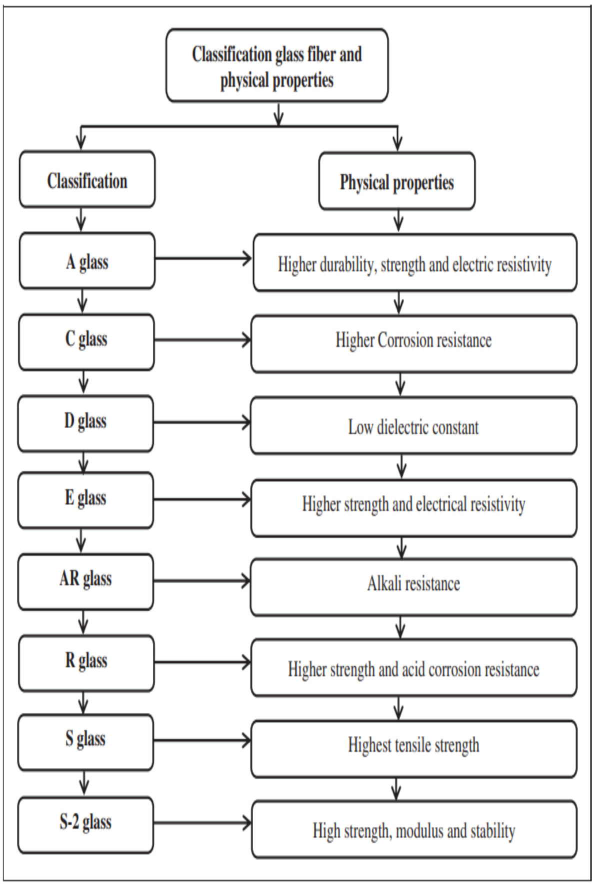
Fatigue Resistance is good
Protection from Weariness in Carbon Fiber Composites is great. Anyway, when carbon fiber bombs it typically flops horrendous without critical outside signs to report its up-and-coming disappointment. Harm in malleable weakness is viewed as decrease in solidness with bigger quantities of pressure cycles, (except if the temperature is high). Carbon fiber is better than E glass in weakness and static strength as well as firmness.

Carbon Fiber has good Tensile Strength Units are MPa This table 5 is offered as a comparison only since there are a great number of variables.

Carbon steel 1090	3600
High density polyethylene (HDPE)	37
High density polyethylene	37
Stainless steel AISI 302	860
Aluminium alloy 2014-T6	483
E-Glass alone	3450
Carbon fiber alone	4127
Carbon fiber in a laminate	1600
Kevlar	2757

Glass fiber-reinforced polymeric

Composite materials produce a combination property of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone.1 Fiber-reinforced composites were successfully used for many decades for all engineering applications.2 Glass fiber-reinforced polymeric (GFRP) composites was most commonly used in the manufacture of composite materials. The matrix comprised organic, polyester, thermostable, vinylester, phenolic and epoxy resins. Polyester resins are classified into bisphenolic and ortho or isophtalic.3 The mechanical behaviour of a fiber-reinforced composite basically depends on the fiber strength and modulus, the chemical stability, matrix strength and the interface bonding between the fiber/matrix to enable stress transfer.4 Suitable compositions and orientation of fibers made desired properties and functional characteristics of GFRP composites was equal to steel, had higher stiffness than aluminum and the specific gravity was one-quarter of the steel.5 The various GF reinforcements like long longitudinal, woven mat, chopped fiber (distinct) and chopped mat in the composites have been produced to enhance the mechanical and tribological properties of the composites.



LITERATURE REVIEW

1. S. Kirthana, Mohammed Khaja Nizamuddin **"Finite Element Analysis and Topology Optimization of Engine Mounting Bracket"**

The 3-D modelling of the mounting bracket has been done in CATIA V5 software. The engine mounting bracket is provided with three holes for fixing the engine body, there is one slot which mounts the engine to the body frame and the load is applied on this slotted part of the bracket. The mounting bracket was designed by Chevrolet motors. Three dimensional models are analyzed in Altair Hypermesh. Altair hypermesh is the neutral preprocessor where we can open IGES, STEP, PARASOLID, CATIA V5R19, SOLIDWORKS, PRO-E, UG and DXF. Mounting bracket is saved as STEP format and opened in hypermesh for doing meshing (tetrahedral mesh). A rigid element is created for the portion of the engine mounting bracket which fits into the slot of the vehicle chasis and the independent node for this rigid is determined. A load of 150N is applied on this node along the Z axis. It is observed that the maximum stress for all designs did not exceed the ultimate tensile strength for the corresponding materials.

2. Andrea Merulla , Andrea Gattob , Elena Bassoli et al. **“Weight reduction by topology optimization of an engine subframe mount, designed for additive manufacturing production”**

The activities carried out and presented herein, have demonstrated that the use of topology optimization, to be further applied in additive manufacturing technologies, in the redesign of parts for, but not limited to, the automotive industry has a clear beneficial effect on weight reduction, while maintaining the structural requirements. The weight reduction is associated with material economy, coupled with reduced energy consumption in the manufacturing stages, and as a secondary consequence, a reduction in fuel consumption of the car. Topology optimization is not self-sufficient, but requires a further re-design step, in which more complex structural analyses as non-linear load cases need to be considered. A result as impressive as a weight reduction of 20% has been obtained, by considering the same material properties of the cast alloy. In this study the possible benefits to have higher mechanical properties of the AM material have not been considered and could turn into further opportunities concerning final part mass reduction.

3. Alok Gupta et al. **“Low cycle fatigue performance of SLM Ti-6Al-4V aero-engine bracket at 200°C: An experimental study”**

The key findings from this study are summarized as below: The SLM Ti-6Al-4V bracket was found to have been designed successfully to operate under the expected thermo-mechanical normal operating loading environment. The aero-engine bracket in a ‘struts & connectors’ shape completed the target cycles at the upper bound of the LCF load condition. The sequential failures in the bracket at higher loading levels, causing elasto-plastic strain, exhibit a distinct design feature of the bracket where it demonstrates redundancies in the load path due to its particular design, with multiple load-carrying struts. The successful outcome of the elevated temperature LCF testing of the bracket is a significant forward step towards adopting the SLM technology for safety critical load bearing applications.

4. Wei Sun et al. **“Fatigue property-performance relationship of additively Manufactured Ti-6Al-4V bracket for aero-engine application manufactured Ti-6Al-4V bracket for aero-engine application An experimental study”**

Tensile and LCF coupon tests were performed to study the mechanical and fatigue properties of the SLM Ti-6Al-4V material. This data was then used to set the test parameters for the LCF tests on the bracket. The mechanical strength (0.2% PS and UTS) of the SLM Ti-6AL-4V was found to be higher than the conventionally made annealed Ti-6Al-4V bar, but the overall ductility values were lower. The higher mechanical strength was due to the needle shape martensitic α’ HCP grains. There was a slight improvement in strength and ductility values with increase in the test strain rate. Cyclic softening was observed in the LCF coupon tests performed at strain levels higher than the material elastic limit. The cyclic softening was attributed to an increase in the dislocation density and formation of martensitic α’ sun-grains in the material. Bracket LCF responses exhibit an excellent flexibility of the structure, under relatively large displacement loads, with insignificant overall plasticity deformation. Local fracture is believed to be related to the stress concentration and possibly the SLM defects. The bracket met the LCF design targets as demonstrated by the cyclic testing. The carefully designed weight optimized bracket has shown good fatigue performance, which is very much needed to build the confidence of practicing engineers for successful deployment of the SLM technology.

5. Sanskar singh Et.al. **“Design of Engine Mount Bracket for an FSAE Car for Deferent Loading Condition”**

The outcome of the study find out the total deformation and equivalent stress at different loading conditions. The value of defamation increases with increasing load at point B so total deformation at 60N is maximum. But the value of total deformation not much change at the applied load at point A. The conclusion of the study the point that point A can be capable at higher loading conditions but point B is not capable at higher loading conditions.

6. Chih-Hsing Liu, Yen-Pin Chiang, and Yi-Yao Hsu **“Optimal Design of an Elastomeric Engine Mount with Desired Stiffness using Topology Optimization”**

In this study, a topology optimization method with a proposed prescribed displacement input boundary condition is developed to design the elastomeric engine mounts. The effects of input angle and the width of rubber block on stiffness values in two different directions are investigated using the proposed topology optimization models. The differences of the obtained stiffness values between the developed numerical models implemented in Matlab environment and commercial finite element analysis software, LS-DYNA, are within 9%. One commercially available elastomeric engine mount is selected as the validation example in this study. The simulated load-displacement relationships agree well with the experimental data. The differences of the obtained stiffness values between finite element simulation and experiment are within 8%. The optimization and simulation models can be further improved by considering the viscoelastic behavior of the rubber material. The design examples and results provided in this study can serve as the design reference for developing elastomeric engine mounts with desired stiffness.

7. Saurabh Srivastava et.al. **"Topology optimization of engine bracket arm using BESO"**

Topology optimization is done on the surface of the engine bracket arm to reduce the weight of the overall assembly of the bracket. The new BESO algorithm is used for the component's topology optimization to reduce the bracket assembly's overall weight. The automobile industry requires lightweight vehicles, which will save materials that can be used for other purposes. The reduced-weight vehicles, in turn, have good fuel economy. The new BESO algorithm made using the Matlab code using the sensitivity factor calculation gives the tool to solve the problems for making the component light in weight. The binary numbers 0 and 1 are considered for material removal and addition, and the parameter considered is von Mises stress. The vonMisesstress criteria give the exact locations on which the optimization is done on the surface. Then the strength of the components is validated by the FEM analysis of the component individually and with assembly. Thus topology optimization is a method for making a lightweight component for vehicles.

8. H. Kursat Celik et.al. **"Strength-Based Design Analysis of a Damaged Engine Mounting Bracket Designed for a Commercial Electric Vehicle"**

FEM-based design analysis of a failed engine mounting bracket specifically designed for a converted electric vehicle was discussed in detail in this paper. The results of the analyses conducted on the bracket revealed that the major reasons for the failure are related to the insufficient part thickness and design faults on the existing bracket geometry. These reasons for failure were eliminated through redesign operation. Failures are frequently referred to as seriously affecting the production costs and durable design reputation of the components used in a converted electric vehicle. To avoid recurrence of the type of failure described in this study, it is recommended that the vehicle should be used within its approved operational conditions and loading limits which are an important failure prevention parameter. To design an engine mounting bracket with high service durability, mechanical characteristics such as yield strength, fatigue strength, and fracture toughness are important properties that should be considered during material selection and appropriate geometry at the design stage. Appropriate fillet radius and part thickness should be considered for the geometry design and the existing sharp features should be avoided. Component assembly should be undertaken with care and by the tolerances to provide durable loading transmissions.

9. Monali Deshmukh, Prof. K R Sontakke **"Analysis and Optimization of Engine Mounting Bracket"**

The optimization of engine mounting bracket is attempted by applying certain changes in its design and shape. After comparison of results obtained from analysis performed, it is concluded that the optimization attempted is found successful. And with the optimization done in the bracket it is found that as the cross-sectional area of the rib is reduced the overall weight of the bracket is also reduced. The modified design of the bracket is obtained which is 12.5% lighter by weight than initial on-optimized bracket. This results in material savings, and overall cost reduction. Also it is confirmed by harmonic analysis that the harmonic response of the modified bracket is within safe limit. So the chances of noisy operation of structure due to its design are minimized.

10. Jasvir Singh Dhillon et.al. **"Design of Engine Mount Brackets for an FSAE car Using Finite Element Analysis"**

The design has been successfully optimized and modified from its preliminary stage. The addition of the rib helped in reducing the maximum deflection by 50% in the worst loading case. The maximum von Mises stress increased from 45.02 MPa to 63.99 MPa, but helped us achieved a more than satisfactory factor of safety of 3.3. Also, even after the addition of material through the rib, the bracket was mass-optimized using HYPERMESH and OPTISTRUCT. The weight of the final design was 356 grams compared to the previous 403 grams. The bracket successfully damps the engine vibrations according to physical testing data. Also, the performance of aluminium at high ambient temperatures of about 110 degrees Celsius was satisfactory, since there is a drop of only 5.5% in the yield strength which brings the factor of safety of 3.15.

Chapter 3

PROBLEM IDENTIFICATION AND OBJECTIVES

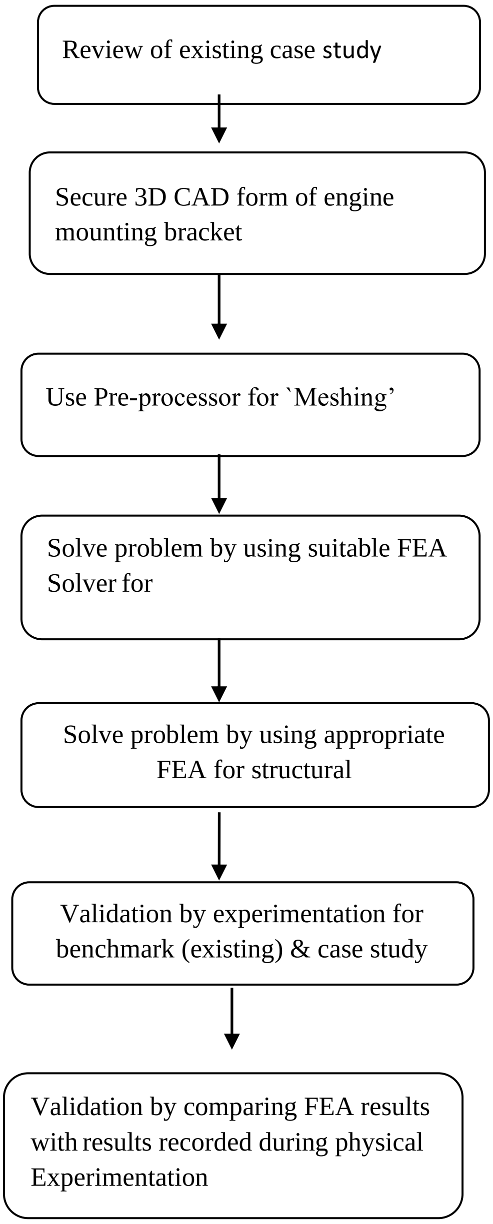
3.1 PROBLEM STATEMENT:

Automotive parts like mount brackets are having weight which leads to increase in total weight of the automobile with less performance for mobility, as it directly affects the mileage & cost. To overcome this problem modeling of bracket will be done in CAD & analyzing in CAE for induced stresses & deformation. Excess material will be searched by region having less stress & that region will be cut & again optimized model is analyzed for comparison with experimental test results.

3.2 OBJECTIVES

- Modelling an engine mounting bracket in Solid works software.
- FEA for stresses and deformation in engine mounting bracket of vehicle
- Topological optimization for the model.
- Optimize model will be manufacturing using aluminium material with reinforcement of glass fibre layer.
- To perform static analysis of both engine mounting bracket with help of ANSYS 21 software.

METHODOLOGY:



FINITE ELEMENT ANALYSIS

- **Introduction of Finite Element Analysis**

The finite element analysis (FEA) is a problem-solving approach for the practical (engineering) problems. The problems are first converted to matrix and partial differential equation forms. Eventually the partial differential and integral equations are being solved to reach the solution of the problem. The volume of the equations to be solved is usually so large that arriving solution without using computer is practically impossible. And, that's why the need of different FEA packages is felt. There are many FEA packages available for different applications. Some popular FEA packages are Pro Mechanica, ANSYS, NASTRAN, and Gambit etc.

In mathematics, the finite element analysis (FEA) is a numerical technique for finding approximate solutions to boundary value problems for partial differential equations. It uses subdivision of a whole problem domain into simpler parts, called finite elements, and variational methods from the calculus of variations to solve the problem by minimizing an associated error function. Analogous to the idea that connecting many tiny straight lines can approximate a larger circle, FEA encompasses methods for connecting many simple element equations over many small sub domains, named finite elements, to approximate a more complex equation over a larger domain.

Finite element analysis (FEA) is a useful and powerful technique for determining stresses and strains in structures or components too complex to analyze by strictly analytical methods. With this technique, the structure or component is broken down into many small pieces (finite number of elements) of various types, sizes and shapes. The elements are assumed to have a simplified pattern of deformation (linear or quadratic etc.) and are connected at "nodes" normally located at corners or edges of the elements. The elements are then assembled mathematically using basic rules of structural mechanics, i.e. equilibrium of forces and continuity of displacements, resulting in a large system of simultaneous equations. By solving these large simultaneous equations system with the help of a computer, the deformed shape of the structure or component under load may be obtained. Based on that, stresses and strains may be calculated. The finite element analysis (FEA) is probably the most versatile way of calculating stress intensity factors. This method primarily involves the evaluation of displacements at nodal points of the body which has been idealized into a system of elements connected at the nodal points. The FEA has become a powerful tool for the numerical solution of a wide range of engineering problems. The FEA has been extensively used to solve problems involving irregular regions and complicated modals.

- **Steps of Finite Element Analysis**

FEA solution of engineering problems, such as finding deflections and stresses in a structure, requires three steps:

1. Pre-processing

2. Solution

3. Post processing

A brief description of each of these steps follows

Step1: Pre-processing

Using a CAD program that either comes with the FEA software or 3D CAD modeling tools like Pro-E, Catia, and solid Edge etc. provided by another software vendor, the structure is modeled. The final FEA model consists of several elements that collectively represent the entire structure. The elements not only represent segments of the structure, they also simulate its mechanical behaviour and properties.

Regions where geometry is complex (curves, notches, holes, etc.) require increased number of elements to accurately

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represent the shape; whereas, the regions with simple geometry can be represented by coarser mesh (or fewer elements). The selection of proper elements requires prior experience with FEA, knowledge of structure's behaviour, available elements in the software and their characteristics, etc. The elements are joined at the nodes, or common points. In the pre-processor phase, along with the geometry of the structure, the constraints, loads and mechanical properties of the structure are defined. Thus, in pre-processing, the entire structure is completely defined by the geometric model. The structure represented by nodes and elements is called "mesh".

Step 2: Solution

In this step, the geometry, constraints, mechanical properties and loads are applied to generate matrix equations for each element, which are then assembled to generate a global matrix equation of the structure. The form of the individual equations, as well as the structural equation is always,

$\{F\} = [K]\{u\}$

Where,

$\{F\}$ = External force matrix,

$[K]$ = Global stiffness matrix,

$\{u\}$ = Displacement matrix.

The equation is then solved for deflections. Using the deflection values, strain, stress, and reactions are calculated. All the results are stored and can be used to create graphic plots and charts in the post analysis.

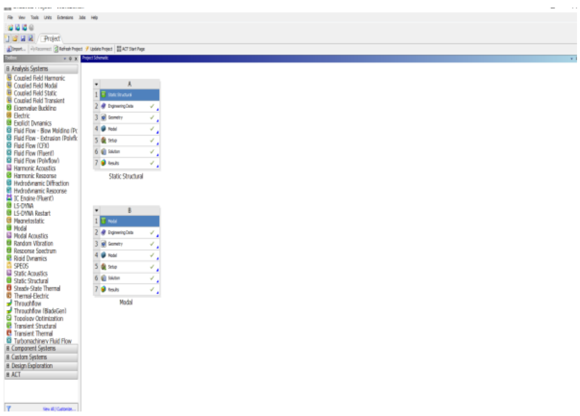
Step 3: Post processing

This is the last step in a finite element analysis. Results obtained in step 2 are usually in the form of raw data and difficult to interpret. In post analysis, a CAD program is utilized to manipulate the data for generating deflected shape of the structure, creating stress plots, animation, etc. A graphical representation of the results is very useful in understanding behaviour of the structure.

In present research for analysis ANSYS (**An**alysis **Sys**tem)software is used. Basically ,its present FEM method to solve any problem. Following are steps in detail

1. Geometry
2. Discretization (Meshing)
3. Boundary condition
4. Solve (Solution)
5. Interpretation of results

Workbench contain analysis of different types namely static, modal, harmonic, explicit dynamics, CFD, ACP tool post, CFX, topology optimizationetc. as per problem defined.



Step 1: Details of material namely copper, steel, grey cast iron, composite material, fluid domain material is defined in engineering data. i.e. ANSYS default material is structural steel.

Step 2: Import of geometry created in any CAD software namely CATIA, PRO E, SOLIDWORK, INVENTOR etc. in geometry section. If any correction is to be made it can be created in geometry section in Design modeller or space claim.

Step 3: In model section after import of component

- Material is assigned to component as per existing material
- Connection is checked in contact region i.e. bonded, frictionless, frictional, no separation etc. for multi body components.
- Meshing or discretization is performed i.e. to break components in small pieces (elements) as per size i.e. preferably tetra mesh and hexahedral mesh for 3D geometry and for 2 D quad or tria are generally preferred.

Step 4: Boundary condition are applied as per analysis namely in fixed support, pressure, force, displacement, velocity as per condition.

Step 5: Now problem is well defined and solve option is selected to obtain the solution in the form of equivalent stress, strain, energy, reaction force etc.

ANSYS Workbench 21.0 platform to perform modal analysis of thrust coupling. ANSYS Workbench 21.0, as the most advanced CAE software, provides users with simulation modules including: structure, fluid, electromagnetic, heat transfer, and other fields. It is the industry's most advanced engineering simulation technology integration platform, with intuitive and friendly interface, convenient pre-processing and post-processing functions, and its extensive solution functions.

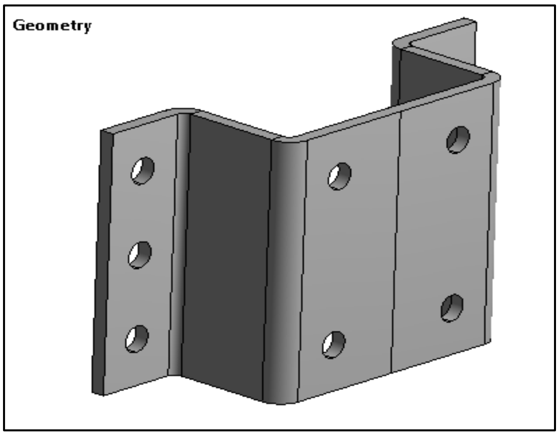


Fig. 2 CATIA model

Properties of Outline Row 3: Structural Steel

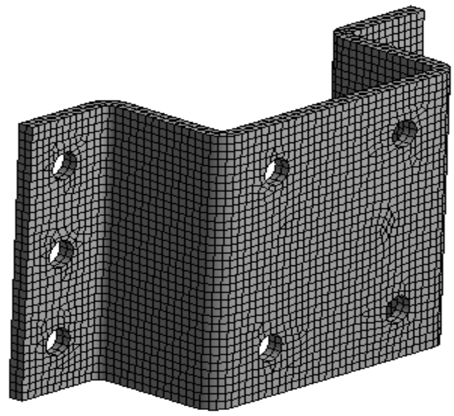
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modulus and Pois...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa

Fig. material properties

Mesh Generation

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

Creating the most appropriate mesh is the foundation of engineering simulations. ANSYS Meshing is aware of the type of solutions that will be used in the project and has the appropriate criteria to create the best suited mesh. ANSYS Meshing is automatically integrated with each solver within the ANSYS Workbench environment. For a quick analysis or for the new and infrequent user, a usable mesh can be created with one click of the mouse. ANSYS Meshing chooses the most appropriate options based on the analysis type and the geometry of the model. Especially convenient is the ability of ANSYS Meshing to automatically take advantage of the available cores in the computer to use parallel processing and thus significantly reduce the time to create a mesh. Parallel meshing is available without any additional cost or license requirements.



Details of "Body Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
Element Size	3.0 mm

Statistics

Nodes	5565
Elements	5348

Details of "Part1"

Graphics Properties	
Definition	
Suppressed	No
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Thickness	7. mm

Fig. 4 Meshing of Engine Bracket

Final existing 4-wheeler Engine Bracket model, it contains 5565 nodes and 5348 elements. Element size was 3 mm

Element Types

When geometries are complex or the range of length scales of the flow is large, a triangular/tetrahedral mesh can be created with far fewer cells than the equivalent mesh consisting of quadrilateral/hexahedral elements. This is because a triangular/tetrahedral mesh allows clustering of cells in selected regions of the flow domain. Structured quadrilateral/hexahedral meshes will generally force cells to be placed in regions where they are not needed. Unstructured quadrilateral/hexahedral meshes offer many of the advantages of triangular/tetrahedral meshes for moderately-complex geometries.

- For simple geometries, use quadrilateral/hexahedral meshes.
- For moderately complex geometries, use unstructured quadrilateral/hexahedral meshes.

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- For relatively complex geometries, use triangular/tetrahedral meshes with prism layers.
- For extremely complex geometries, use pure triangular/tetrahedral meshes.

Boundary Conditions

Loading

Loads: Specific values of load are implemented for a typical mounting bracket. Load is applied at the two holes of the engine mounting bracket, which are connected to the engine structure with the help of rigid elements such as nut and bolts

Engine Weight = 1100kg

Weight Acting On One Bracket= 1100/4= 275kg

Weight In Newtons= 275*9.81=2697.75N

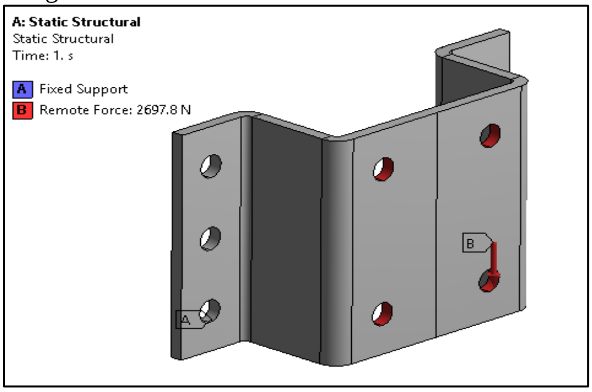


Fig.5 Boundary Condition to Engine Bracket

Total Deformation

The total deformation & directional deformation are general terms in finite element methods irrespective of software being used.

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems.

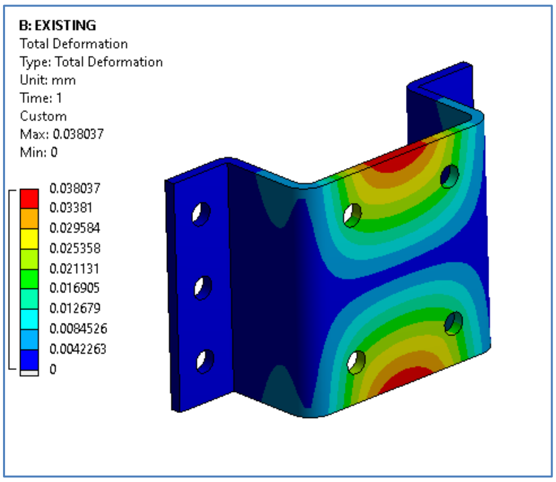


Fig.6 Total Deformation of Engine Mounting Bracket

Equivalent Stress

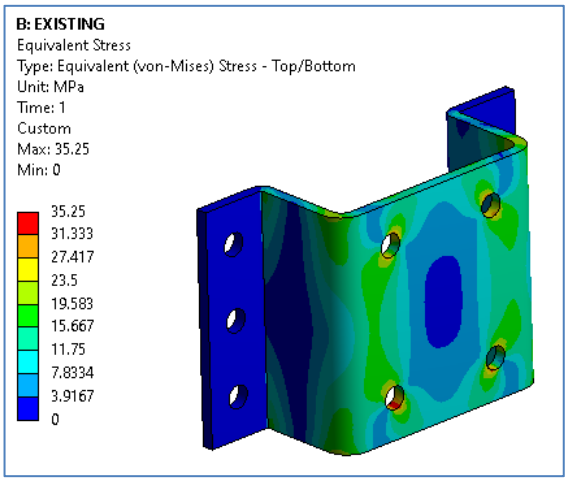


Fig.7 Equivalent stress on Engine Bracket

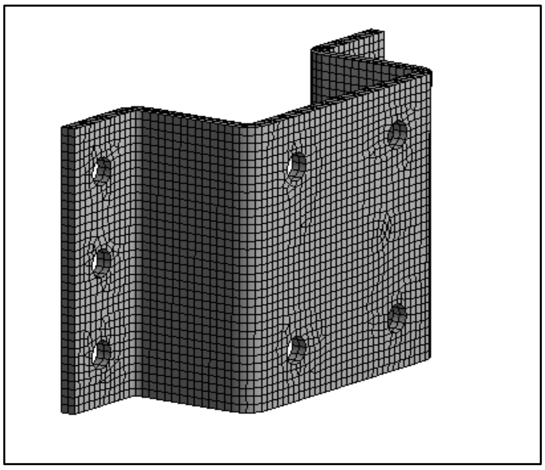
FEA of Aluminium Engine Mounting Bracket

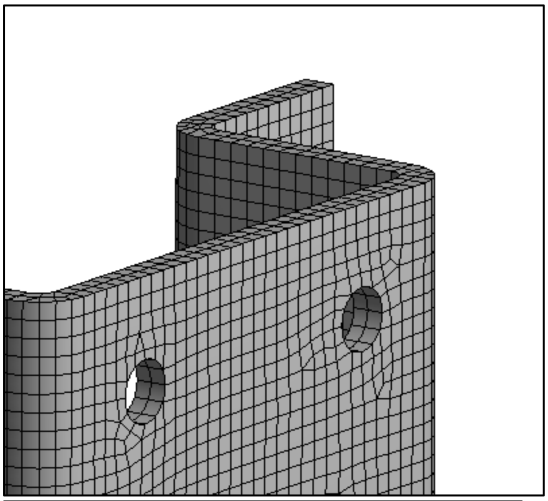
Material properties

Properties of Outline Row 3: Aluminum Alloy

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	2770	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	2.3E-05	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modulus a...	
8	Young's Modulus	7.1E+10	Pa
9	Poisson's Ratio	0.33	
10	Bulk Modulus	6.9608E+10	Pa
11	Shear Modulus	2.6692E+10	Pa

Mesh





Details of "Body Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	5 Bodies
Definition	
Suppressed	No
Type	Element Size
Element Size	4.0 mm

Fig mesh of Aluminium Engine Mounting Bracket

Boundary condition

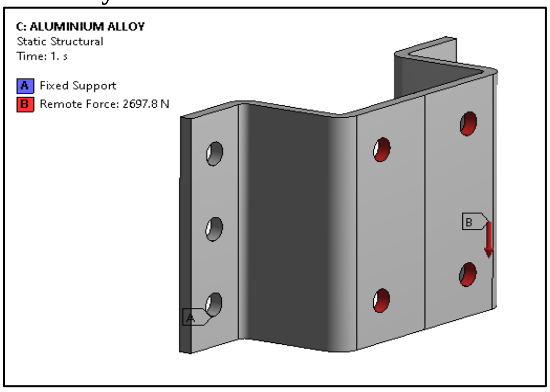


Fig boundary condition of Aluminium Engine Mounting Bracket

Statistics	
Nodes	39794
Elements	8539

Total deformation

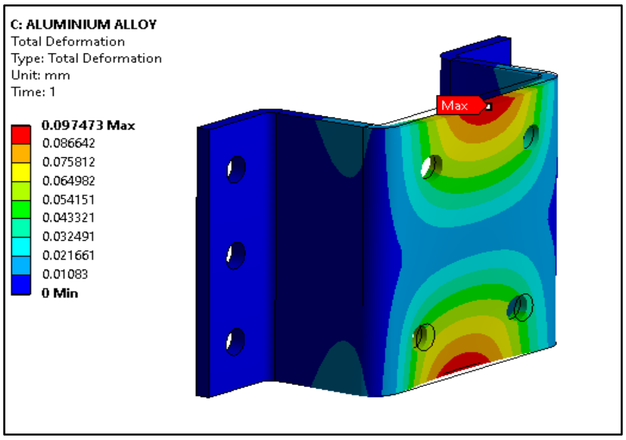


Fig Total deformation of Aluminum Engine Mounting Bracket

Equivalent stress

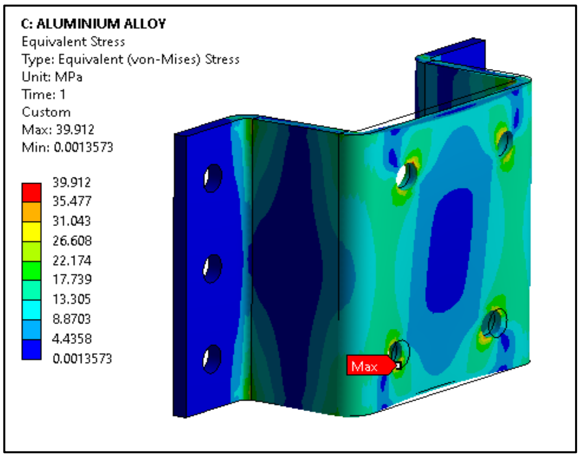


Fig Equivalent stress of Aluminium Engine Mounting Bracket

Principal stress

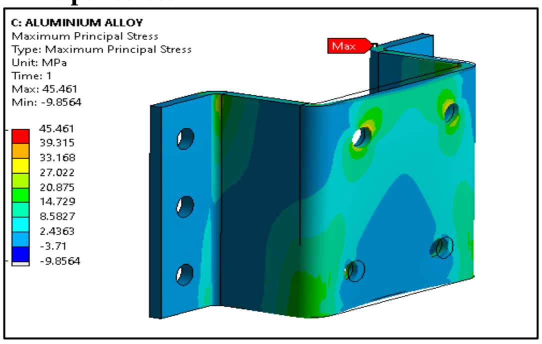


Fig Principle stress of Aluminium Engine Mounting Bracket

FEA OF ALUMINIUM ENGINE MOUNTING BRACKET WITH GLASS FIBRE

Material properties of glass fibre

Properties of Outline Row 3: E-Glass

	A	B	C
1	Property	Value	Unit
2	Density	2600	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
5	Isotropic Elasticity		
6	Derive from	Young'...	
7	Young's Modulus	7.3E+10	Pa
8	Poisson's Ratio	0.22	
9	Bulk Modulus	4.3452E+10	Pa
10	Shear Modulus	2.9918E+10	Pa

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Properties	
Total Thickness	7. mm
Total Mass	1.8227 kg

Layer information

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
4	E-Glass	1	0
3	E-Glass	1	0
2	E-Glass	1	0
1	Structural Steel	4	0
(-Z)			

Boundary condition

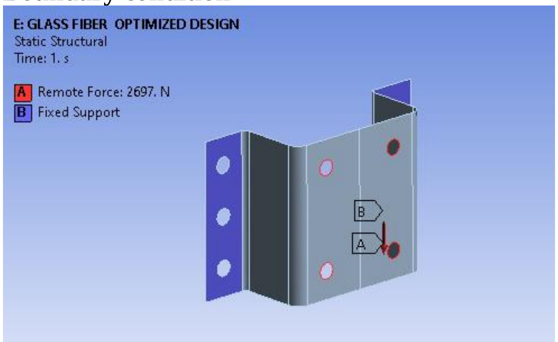


Fig Boundary condition of Aluminium Engine Mounting Bracket with glass fibre

Total deformation

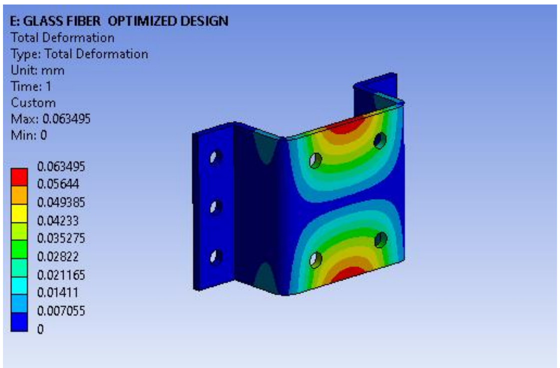


Fig Total deformation of Aluminium Engine Mounting Bracket with glass fibre

Equivalent stress

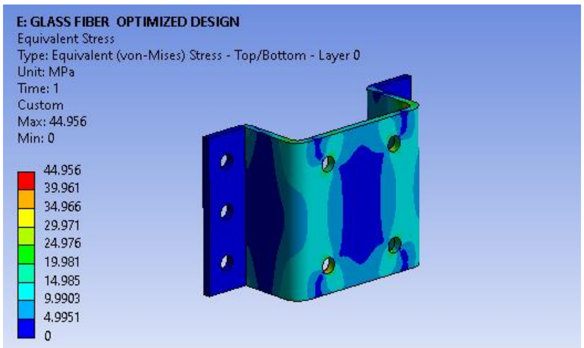


Fig Equivalent stress of Aluminium Engine Mounting Bracket with glass fibre

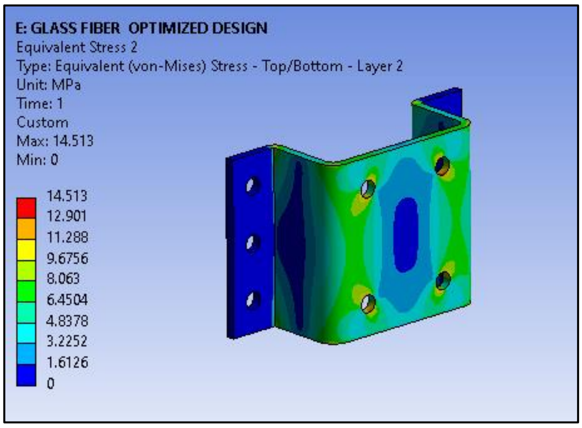


Fig Equivalent stress of Aluminium Engine Mounting Bracket with glass fibre

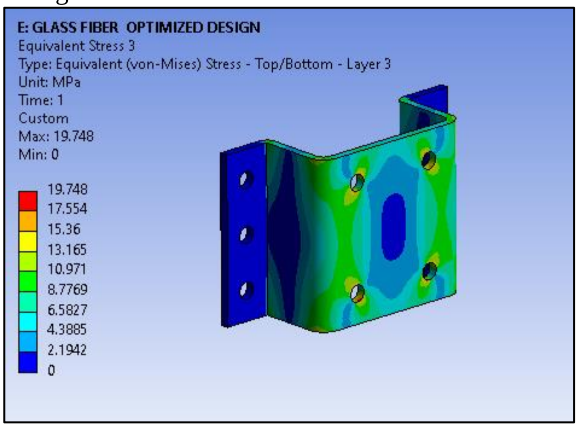
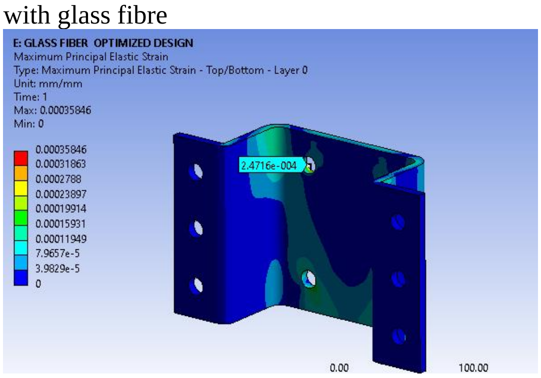


Fig Equivalent stress of Aluminium Engine Mounting Bracket with glass fibre



Strain is observed around 247 microns using FEA

Conclusion

The design and static structural analysis of steel Engine Mounting Bracket and Aluminium Engine Mounting Bracket with glass fibre has been carried out. Comparison has been made between Aluminium Engine Mounting Bracket with glass fibre with steel Engine Mounting Bracket having same design and same load carrying capacity.

1. The stresses in the Aluminium Engine Mounting Bracket with glass fibre of design are much lower than that of the allowable stress.
2. The strength to weight ratio is higher for composite Engine Mounting Bracket than conventional steel Engine Mounting Bracket with similar design.
3. Weight of the composite Engine Mounting Bracket by using material Aluminium, Glass fibre, was 1.8227 kg, for less weight of the spring mechanical efficiency will be increased.

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